REMARKS

Claims 1-4, 7-8, 10-15, 19-20, 22-23, 25-33 are pending. Claims 5-6, 9, 16-18, 21, and 24 were previously canceled. Claims 1, 2, 10, 12, 13, 22, 23, 31 and 33 have been amended to more clearly recite the subject matter of the present disclosure. In particular, all of the independent claims (Claims 1, 2, 12, 13, 22, 23, and 33) have been amended to recite "heating for a time of a few seconds to 5 minutes". Support for this amendment exists in the specification with respect Example 1, paragraph [0067] which states, "intercalated graphite flakes were expanded by exposure to microwave energy, typically at 2.45 GHz frequency, for a few seconds to a few minutes in an oven." Claims 10 and 31 were amended to correct for formalities to be discussed in more detail below. No claims are allowed.

I. SUMMARY OF OBJECTIONS/REJECTIONS

The Examiner sets forth the following objections/rejections:

1. Objection of Claim 10 under 37 C.F.R. § 1.75(c) as being in improper form for being a multiple dependent claim dependent upon another multiple dependent claim.

2. Objection of the amendment filed 5/10/07 under 35 U.S.C. § 132(a) for allegedly introducing new matter into the disclosure for the range "up to five minutes".

3. Provisional rejection of the claims on the ground of nonstatutory obviousness-type double patenting as being unpatentable over Claims 1-4, 6-15, 17-22, and 29-30 of co-pending Application No. 11/361,255.

4. Claim 31 is rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. In particular, the Examiner takes issue with the recitation of "1040 Watts".

5. Claims 1-4, 7-8, 10-15, 19, and 29-30 are rejected under 35 U.S.C. § 102(b) as being anticipated by Saito et al. U.S. Pat. No. 6,024,900 ("Saito") with Krassowski et al. U.S. Pat. No. 6,395,199 ("Krassowski") and Caines U.S. Pat. No. 4,199,628 ("Caines") being cited as evidence that the temperatures of Saito allegedly give the instantly claimed "worm-like" structure.

6. Claims 1-4, 7-8, 10-15, 19, and 29-30 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Saito with Krassowski and Caines being cited as evidence that the temperatures of Saito allegedly give the instantly claimed "worm-like" structure.

7. Claims 1-4, 7-8, 10-15, 19-20, 22-23, and 25-33 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Saito in view of Adams et al. U.S. Pat. No. 6,200,915 ("Adams"), Ottinger et al. U.S. Pre-Grant Publication No. 2002/014952 ("Ottinger"), Blain et al. U.S. Pat. No. 6,413,601 ("Blain"), and Cha et al. U.S. Pat. No. 5,164,054 ("Cha"), Greinke et al. U.S. Pat. No. 6,555,271 ("Greinke"), Bonville U.S. Pat. No. 6,248,462 ("Bonville"), and Von Bonin et al. U.S. Pat. No. 5,288,429 ("Von Bonin") with Krassowski and Caines being cited as evidence that the temperatures of Saito allegedly give the instantly claimed "worm-like" structure.

II. OBJECTIONS ARE OVERCOME

1. Claim 10 has been amended to depend from Claim 1 or 2 which are both independent claims. Accordingly, Claim 10 no longer depends from a multiple dependent claim. Applicants request that the objection under 37 C.F.R. § 1.75(c) be withdrawn.

The Examiner states that "claims 4, 7, 8, 10, 11 have not been further treated on the merits." These claims were amended in the amendment dated March 13, 2008 to correct for dependence upon multiple dependent claims.

Applicants submit that these claims in particular are in proper form and depend from independent claims (not multiple dependent claims) and thus should be examined on the merits. In fact, the Examiner states in paragraph 1 of the outstanding action, page 2, "The amendment of 3/17/08 has been entered. Claims 1-4, 7-8, 10-15, 19-20, 22-23, and 25-33 are pending." Formal examination of these claims on the merits is requested.

2. The Examiner sets forth his previous objection under 35 U.S.C. § 132(a) for allegedly introducing new matter into the disclosure for the range "up to five minutes". The claims in the instant case were previously amended as evidenced by the amendment of March 13, 2008 to recite "3-5 minutes" as deemed acceptable by the Examiner, (See e.g., the outstanding action, ¶ 3, "3-5 minutes is noted in the originally filed specification".) Applicants are puzzled why this objection continues to be applied against the application since Applicants made these amendments in an effort to advance prosecution. Regardless, the claims have been amended to recite "a few seconds to 5 minutes". The amendment is supported in the specification and overcomes this rejection as discussed in more detail below. Applicants submit that this objection has been overcome request that the objection be withdrawn.

III. NONSTATUTORY DOUBLE PATENTING REJECTION IS OVERCOME

The claims were rejected based upon double patenting over a co-pending application, 11/361,255. Enclosed is the required Terminal Disclaimer to overcome this rejection. Reconsideration is requested.

IV. REJECTION UNDER 35 U.S.C. § 112, FIRST PARAGRAPH

Claim 31 is rejected as failing to comply with the written description requirement. Claim 31 has been amended to recite "expanded by heating at a power of 1040 Watts for 3 minutes" as suggested by the Examiner in

paragraph 6A of the outstanding action. This amendment is made to further advance prosecution to completion. Reconsideration is requested.

V. REJECTION UNDER 35 U.S.C. § 102(b)

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631 (Fed. Cir. 1987). As set forth in detail below, Applicants respectfully submit that the applied reference fails to disclose all recited limitations of the Applicant's claims. Accordingly, the claims are not anticipated and the Applicant requests withdrawal of the anticipation rejections of all Claims 1-4, 7-8, 10-15, 19, and 29-30.

A. Summary of the Rejections under 102(b)

The Examiner rejects Claims 1-4, 7-8, 10-15, 19, and 29-30 under 35 U.S.C. § 102(b) as being anticipated by Saito. In particular, the Examiner states, "It is not seen that the heating means of the instant claims gives a different result than that of the patentee via probative evidence that is commensurate in scope with the instant claims and the cited prior art." (See e.g., outstanding action, ¶ 9.)

B. Summary of the Applied Reference

Saito teaches that production of expanded graphite from the raw material can be conducted by a known process. "For example, concentrated sulfuric acid is mixed with hydrogen peroxide to form peroxomonosulfuric acid; thereto is added raw material graphite with stirring to give rise to a reaction for about **1 hour to 1 day**; and the reacted graphite is heated at 500-1000°C in an inert gas". (Saito, col. 2, lines 59-65, emphasis added). According to Saito, "The present invention may be expanded graphite obtained by adding 15% ammonium hydrogenperoxodisulfate to a mixture of 320 parts by weight of 95 wt. % concentrated sulfuric acid and 4 parts by

weight of 62% hydrogen peroxide, mixing them with cooling to 20°C or lower, adding natural graphite to the mixture to give rise to a reaction for **24 hours**, and firing the reaction product up to 1000°C in nitrogen gas" (col. 2, line 67 to col. 3, line 12, emphasis added). Moreover, Saito discloses, "Further, it is necessary that at least 80% of the total particles of the graphite powder used in the present invention have particle diameters of 0.1-20 μm." (Saito, col. 3, lines 34-36.) Saito describes using a conventional heating process to expand the graphite. Saito does not disclose or suggest that a microwave process for a very limited period of time should be used to produce expanded graphite having superior properties as compared to graphite expanded by a high temperature heat treatment.

C. The structure implied by a product-by-process claim is considered when assessing patentability over the prior art

The structure implied by the process steps should be considered when assessing the patentability of product-by-process claims over the prior art, especially where the product is defined by the process steps by which the product is made, or where the manufacturing process steps would be expected to impart distinctive structural characteristics to the final product. See, e.g., *In re Garnero*, 412 F.2d 276, 279, 162 USPQ 221, 223 (CCPA 1979). MPEP 2113.

Affidavits or Declarations, when timely presented, containing evidence of criticality or unexpected results, commercial success, long-felt but unsolved needs, failure of others, skepticism of experts, etc., must be considered by the Examiner in determining the issue of obviousness of claims for patentability under 35 U.S.C. 103. The Court of Appeals for the Federal Circuit stated in *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538, 218 USPQ 871, 879 (Fed. Cir. 1983) that "evidence rising out of the so-called 'secondary considerations' must always when present be considered en route to a determination of obviousness." Such evidence might give light to circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or unobviousness, such evidence may

have relevancy. *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966); *In re Palmer*, 451 F.2d 1100, 172 USPQ 126 (CCPA 1971); *In re Fielder*, 471 F.2d 640, 176 USPQ 300 (CCPA 1973). MPEP 716.01(a).

D. Saito fails to disclose each element of applicants' claims

Independent Claims 1, 2, 12, and 13 of the present application include a product-by-process limitation reciting "expanded by heating in a microwave or radiofrequency applicator for a time of a few seconds to 5 minutes to remove by boiling." Accordingly, the structure implied by the microwave or radiofrequency wave treatment step should be considered. The microwave or radiofrequency wave treatment provides beneficial and structurally different results according to the relevant evidence provided in the prior Office Action responses.

In particular, the Declaration under 37 C.F.R. § 1.132 by the inventor, professor Lawrence T. Drzal, filed on June 22, 2006 states, "graphite expanded by a microwave process has a higher degree of expansion and has a cleaner surface than graphite expanded by a heat treatment." (See Declaration, page 3.) Included in the Declaration is chapter 2 of the dissertation of Hiroyuki Fukushima (also an inventor of the present application), entitled "Exfoliated Process for Graphite Intercalation Compounds, attached as Exhibit A. This chapter explains that graphite expanded by a microwave process has superior properties as compared to graphite expanded by a heat treatment. In particular, the dissertation explains in pertinent part:

> - "The surface areas of microwave exfoliated graphite samples were more than 4 times larger than those of the heat exfoliated samples." - Fukushima, page 84, 2nd paragraph. , (Also see, Figure 2.11 and Table 2.1.)
>
> - "It revealed that the microwave process could give a better degree of expansion and a cleaner surface at lower cost." – Fukushima, page 71, 2nd paragraph.
>
> - "By comparing the heating process, Figure 2.4, and the microwave process, Figure 2.6, it was shown that microwave

process could give the same or better degree of expansion for graphite flakes." - Fukushima, page 82, 3rd paragraph.

- "It revealed that overall microwave treatment showed a better degree of expansion than conventional heating process, including heating at the temperature of 600°C to 800°C, which is commonly used in the commercial expansion processes." - Fukushima, page 84, 1st paragraph. (See also, Figures 2.7, 2.8, 2.9, and 2.10.)

- "The physical principle of dielectric heating, which includes microwave and radio frequency heating, is based on the transformation of electromagnetic field energy into thermal energy in polar materials. Dipoles of polar materials change their direction by following the direction of the electromagnetic field, causing friction between molecules and transform the applied microwave energy into thermal energy. Microwave process has many advantages over conventional heating such as less energy consumption, faster process, *homogeneous and simultaneous heating throughout the whole sample*, and higher process capacity. Because of these advantages, the microwave process also offers a considerable cost reduction. Fukushima, page 82, 1st paragraph.

The fuming inorganic oxy acid has higher dielectric constant than graphite. This enables the radiofrequency waves or microwaves to heat the acid inside the precursor graphite more efficiently, causing explosive expansion of the graphite. Conventional heating methods only heat the graphite gradually from outside, offering relatively slow heating which causes relatively slow and less effective expansion.

The Examiner sates, "It would appear that these different energy forms would lead to the same products, particularly given the lack of specificity of the instant claims in establishing any unobviously different structure between the two graphites." (See e.g., outstanding action, ¶ 9.) The Examiner has not provided sufficient weight to the comparison provided in the Fukushima dissertation from section 2.3.3, pages 84 – 94. As shown hereinabove by the pertinent portions of the Fukushima dissertation, microwave expanded graphite is significantly different than heat treated graphite. Moreover, a consideration of "unobviously different structure" is improper for an

anticipation rejection since the prior art reference must disclose each and every element of the Applicants claims.

Saito fails to disclose the process of heating the graphite with radiofrequency waves or microwaves for a time of a few seconds to 5 minutes. Saito also fails to disclose expanded graphite that is pulverized to produce the platelets, which consist essentially of a distribution of single platelets. Moreover, Claims 2 and 13 each recite platelets that have a thickness of about 30 nm. Saito fails to disclose graphite platelets of this thickness. In fact, Saito teaches away from this recitation since it states, "Further, it is necessary that at least 80% of the total particles of the graphite powder used in the present invention have particle diameters of 0.1-20 um." (See e.g., Saito, col. 3, lines 34-36.) Accordingly, Saito fails to disclose each element of Applicants' independent claims and thus, the anticipation rejection is overcome. Applicants request that the anticipation rejection be withdrawn.

VI. CLAIM REJECTIONS UNDER 35 U.S.C. § 103(a)

A *prima facie* case of obviousness requires that each and every limitation of the claim is described or suggested by the prior art, or would have been obvious based on the knowledge of those of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 1074 (Fed. Cir. 1988). Accordingly, the failure of the applied references to teach or suggest all recited claim limitations precludes a conclusion of prima facie obviousness. *In re Fine*, 837 F.2d 1071, 1074 (Fed. Cir. 1988); MPEP § 2143. The implied structure of the process step of microwave or radiofrequency wave treatment is different then that of Saito alone or in combination with any of the applied references as evidenced by the Declaration. Saito alone or in combination with the applied references fails to disclose, teach or suggest all recited elements of the claims since neither reference describes the process step of microwave or radiofrequency treatment.

The evidence provided, (i.e., the Declaration and appended dissertation) shows that microwave treated graphite is unique over

conventional heating. In view of the asserted prior art references, this difference is equivocal to unexpected results since neither Saito alone or in combination with any of the applied references disclose, teach or suggest microwave treated graphite.

Thus, the Applicants submit that the present obviousness rejections are traversed. Accordingly, the Office Action fails to present a *prima facie* case of obviousness for all pending claims.

A. Summary of the Applied References

Adams describes a textile fabric coated with an elastomer silicone composition with laminar form. Expanded graphite is mentioned in a range from 5 to 500 μm (microns; 5 to 500 x 10-6 M). These are conventional expanded graphite particles which are much different from those of the present invention which have been expanded with microwaves or radiofrequencies for a few seconds to 5 minutes as now claimed.

Ottinger describes conventional expanded graphite in its expanded form as described at paragraph [0036]. The graphite is not expanded using microwaves or radiofrequency heating for a few seconds to 5 minutes as in independent Claims 1, 12, 13, 21, 22 and 29.

Blain describes a thermal insulating device composed of layers of graphite separated by layers of polymer. Blain teaches that graphite flakes can be exfoliated by exposing them to an energy source, including microwave or radiofrequency radiation. However, Blain does not discriminate between microwave radiation and other sources of energy, such as heat sources including a flame or energy provided by infrared radiation in relation to the direction of heating. The present independent claims recite "for a time of a few seconds to 5 minutes so as to remove by boiling the chemical comprising a fuming organic oxy acid from the precursor graphite." Blain does not disclose the time period for microwave heating or the precursor graphite comprising the fuming organic oxy acid. As can be seen from the Declaration, the microwave treatment provides structural benefits as described above.

Cha describes a process for producing hydrogen and carbon black. There is no discussion of expanding graphite. This reference is remote from the present invention and one skilled in the art could not possibly derive expanding of graphite using microwaves or radiofrequency waves for a few seconds to 5 minutes from this reference. The production of hydrogen from graphite is not even remotely related to the claimed invention.

Greinke relates to a lithium ion battery. This reference teaches that graphite is laminated to a metal substrate. An anode is created from exfoliated graphite. The examples refer to "worms" of exfoliated graphite. This reference is remote from the present invention since there is no suggestion of the graphite expanded for a few seconds to 5 minutes with microwave or radiofrequency heating.

Bonville describes a "porous graphite" anode alone or in combination with a polymer and catalyst for use in an electrochemical free cell assembly. There is no suggestion of the presently claimed invention comprising microwave or radiofrequency wave expanded for a few seconds to 5 minutes from this reference.

Von Bonin describes a process for expanding graphite in a mold using a liquid in graphite. Von Bonin teaches that microwaves are one method of heating the expandable graphite, but does not teach advantages of a microwave treatment over conventional heating. There is no suggestion of heating for a few seconds to 5 minutes with microwaves or radiofrequency waves.

B. The applied references alone or in combination fail to disclose, teach or suggest each element of the applicants' claims

According to MPEP 2113, the structure implied by the process steps should be considered when assessing the patentability of product-by-process claims over the prior art, especially where the product can only be defined by the process steps by which the product is made, or where the manufacturing process steps would be expected to impart distinctive structural characteristics to the final product. *In re Garnero*, 412 F.2d 276, 279, 162

USPQ 221, 223 (CCPA 1979) (holding "interbonded by interfusion" to limit structure of the claimed composite and noting that terms such as "welded," "intermixed," "ground in place," "press fitted," and "etched" are capable of construction as structural limitations). The graphite in the claims of the present application have been described by a product-by-process limitation. The precursor graphite has been expanded by heating in a microwave or radiofrequency wave applicator. Therefore, the structure implied by the process steps should be considered when assessing the patentability of the claims over the prior art.

Adding energy via microwave or radiofrequency by heating over a period of a few seconds to 5 minutes produces different platelets than those of the prior art. The Declaration Under 37 CFR 1.132 illustrates that graphite expanded by the claimed microwave or radiofrequency process for a few seconds to 5 minutes has superior properties as compared to graphite expanded by a heat treatment. The graphite expanded by a microwave process has a higher degree of expansion and has a cleaner surface than graphite expanded by a heat treatment. As can be seen in Table 2.1 and in Figure 2.11 on page 88 of the dissertation of Hiroyuki Fukushima, entitled "Exfoliated Process for Graphite Intercalation Compounds", microwave exfoliated graphite has approximately a ten fold higher surface area and aspect ratio than heat exfoliated graphite. In addition, since intercalated acid residue remaining on the graphite surfaces after treatment could cause problems, the cleanness of the graphite surface is important. Section 2.3.3.2 on page 89 of the dissertation of Hiroyuki Fukushima shows that the microwave treatments have an advantage over the conventional heating process in terms of removal of the residual intercalates. Thus, graphite expanded by a microwave process has superior properties as compared to graphite expanded by conventional heating processes.

The Examiner has not given proper consideration to the evidence previously submitted by the Applicants related to microwave heating. Moreover, the Examiner has not rebutted the evidence provided in the Declaration and associated dissertation. The Examiner has not provided

evidence or pointed to a reference which would indicate that microwave heating does not provide unique and unexpected results as shown by the Applicants.

These results are unexpected considering the teachings of the cited references. None of the cited references alone or in combination teach the advantages of graphite expanded by the claimed microwave or radiofrequency wave process for a few seconds to 5 minutes. Saito, Adams, Ottinger, Blain, Cha, Greinke, Bonville, and Von Bonin, either taken alone or in combination, do not disclose, teach or suggest the Applicants' independent claims. Applicants request that the obviousness rejections be withdrawn.

VII. AMENDMENT TO RECITE "A FEW SECONDS TO FIVE MINUTES"

The claims have been amended to recite generally heating by microwave or radiofrequency waves for a time of a few seconds to 5 minutes to remove by boiling the chemical. In previous Office Actions, the Examiner has rejected the limitation of "up to 5 minutes". The claims are supported in the specification as discussed above.

The Patent and Trademark Office ("PTO") determines the scope of claims in patent applications not solely on the basis of the claim language, but upon giving claims their broadest reasonable construction "in light of the specification as it would be interpreted by one of ordinary skill in the art." *In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364[, 70 USPQ2d 1827] (Fed. Cir. 2004). The language of the claims must be read in the context of the claim language. The claim recites a conjunctive limitation, "a precursor graphite has been expanded by heating in a microwave or radiofrequency applicator for a time of a few seconds to five minutes" and "to remove by boiling an expander chemical." Thus, the limitation requires both that "boiling" and for a time period of "a few seconds to five minutes" be performed in the process step. Clearly, boiling an intercalcant for time period of zero is not possible since by definition, at zero time, no boiling can be achieved. A precise lower limit is a few seconds and will depend on specific environmental

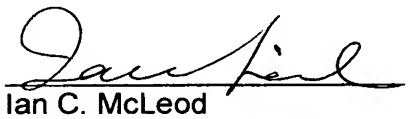
and/or laboratory conditions and parameters. These parameters can be determined by the skilled artisan when practicing the claimed invention.

Support for the time range of a few seconds to 5 minutes exists in the original specification as previously discussed. The specification provides support for the upper limit of 5 minutes with respect to paragraph [0062]. Moreover, support for less than 3 minutes exists with respect to paragraph [0067] in Example 1. (i.e., "a few seconds to a few minutes".) Accordingly, the time period of "a few seconds to 5 minutes" is fully supported by the written description of the application as filed.

VII. CONCLUSION

The Applicants submit that Claims 1-4, 7-8, 10-15, 19-20, 22-23, 25-33 are in condition for allowance. The remarks provided herein overcome the objections and rejections set forth by the Examiner. The applied references alone or in combination fail to anticipate and/or render obvious the claims. Accordingly, the Applicants respectfully request that a Notice of Allowance be issued and the objections and rejections be withdrawn.

Respectfully,



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